Space Weather Technical Forecast

Issued on Saturday, 08 October 2022 at 13:13 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of M-class flares. Marginal Active electron fluence reducing.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Moderate over the past 24 hours, with a solitary long-period M1.0 flare seen at GOES16 at 07/1443UTC. This was preceded and followed by a ramping and decline in occasional C-class activity, but this has since fallen back to the B/C X-ray flux boundary into the current UTC day (Saturday 08 October). The sunspot responsible was AR3116, which saw slight spreading and rearrangement of its constituent spots, finishing the period as an Eai/Beta-Gamma.

Including the above, there were seven sunspot regions on the current disc. Perhaps the main change was in the apportionment of AR3112, which saw its leading spots re-assigned as AR3120 - a Bxo/Beta, although this still left its sizeable parent AR3112 as Fki/BGD. AR3112 remains the most notable region on the disc on paper, with its leading group containing a Mt Wilson delta spot and a candidate for another, although flare activity has so far been limited to mid C-class, perhaps because the energy of the spot is well-spread across its span on the disc. The main development on the current front side was minor growth in the trailing spots of AR3118 and AR3119 in the eastern solar hemisphere, while the western groups of AR3111 and AR3115 saw the opposite tendency and faded a little.

There are currently numerous filaments scattered across the disc. A possible prominence eruption narrowly over the northwestern limb is thought to be the reason for the main event on coronagraphs visible in the period - into daylight hours UTC of Saturday - although this will not affect Earth and no proton enhancement appears to have resulted. No Coronal Mass Ejections (CMEs) were visible in available coronagraph imagery.

Solar Wind / Geomagnetic Activity: The solar wind, as measured by DSCOVR and ACE at L1, remained orientated away from the sun (positive phi angle). The erratic and occasionally rising Elevated solar wind speed may be symptomatic of passing between positive coronal holes - probably CH28/+ and CH30/+ on the northwestern limb, but perhaps also CH29/+. This final feature is still thought more likely to arrive later in the current UTC weekend, however.

The solar wind speed rose into the mid-500s of km/s, eventually resuming its previous decline into the high-400s during the UTC morning of Saturday. The solar wind density showed a slight fall over the same interval, from around 10ppcc to single figures. The IMF peaked early in the 24 hours at 8nT, gradually reducing thereafter. The north-south component was initially mainly co-aligned with Earth's field to a peak of +6nT, gradually drifting to more neutral values and then anti-aligned, with the maximum southward deflection to -7nT, though often less.

The net result of the above solar wind measures was for Quiet to Unsettled activity, peaking at a provisional Kp 3o to start and end the reporting period.

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Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured at GOES16, has been at Background levels.

High energy electron flux (greater than 2MeV) has been at Moderate to High levels, peaking at 2900pfu at 07/1525 UTC. The associated 24-hour fluence rose to be above the Active threshold in the period, with the 08/0001UTC observation being 1.14e8 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is forecast to be Low to Moderate, with the possibility of further M-flares from AR3116. Whilst AR3112 has remained relatively stable, this still has the potential for M-class flares and a Slight Chance of X-class.

Solar Wind / Geomagnetic Activity: There are no Earth-directed CMEs in the forecast, however a CME due to a filament eruption observed 07/0730UTC may conduct a close pass of the Earth on Tuesday 11 October, with peripheral influences possible.

Otherwise, current elevated solar winds are expected to perhaps ease day 1 (8th) for a time, before a further enhancement from any fast wind arrival of CH29 either later day 1 or day 2 (8th or 9th). This is low confidence, due to its small size and being new on this rotation. Any enhancement is then likely to ease by day 4 (11th).

Quiet to Unsettled geomagnetic activity is expected at first, with a chance of rising to Active, and a slight chance of G1/Minor Storms late day 1 and day 2 (8th and 9th) from any fast wind arrival. Easing back to Quiet to Unsettled day 3 and 4, (10th and 11th) with a slight chance of Active.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10MeV) is expected to be near Background for much of the period, but with a Slight Chance of rising to S1 in response to any large flares from AR3112 and perhaps AR3116.

Electron flux (greater than 2 MeV) is likely to persist at Moderate to High levels, albeit with a slight suppression possible from any fast wind enhancement that occurs in Earth's solar wind environment late on day 1 or early day 2 (UTC weekend). The associated electron fluence is forecast to persist at Active levels, only gradually declining later in the period.

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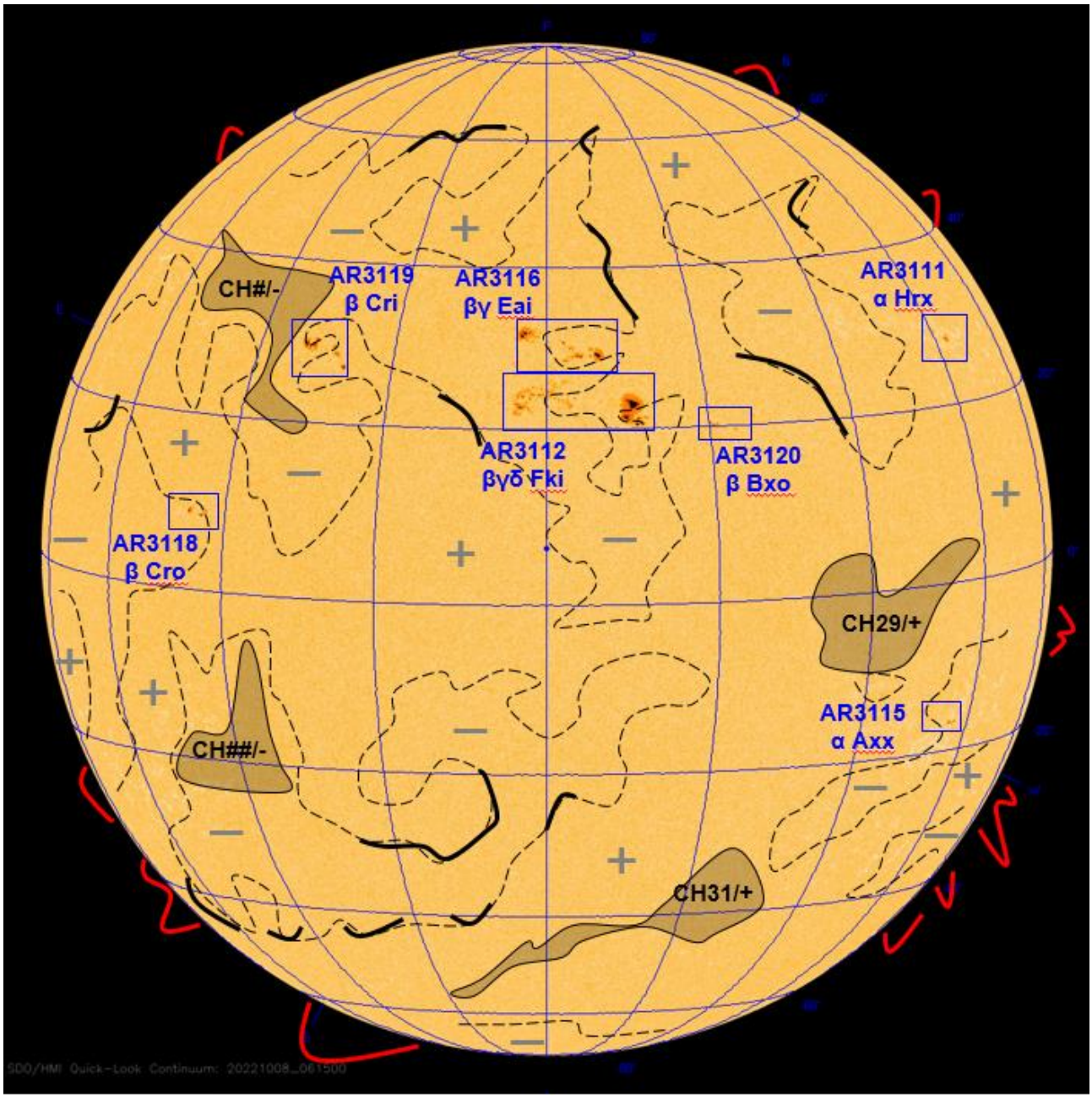
Figure 1. Solar Analysis Valid 08/0615UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

There are now no Earth-directed CMEs in the forecast. However a filament eruption in the northeast disc was observed at 07/0730UTC, with the subsequent ejecta from the CME expected to miss passing ahead and north of Earth. However there is the potential for a very slight glancing interaction late on day 4 (11th) as this passes close by.

Solar winds at Earth have continued at Elevated levels, potentially due ongoing fast winds from previous coronal holes (CH28 and CH30), coupled with the peripheral influence of passing CMEs, however the later cannot be confidently identified amongst the solar wind due to their very weak impacts.

Solar winds are now expected to ease day 1 (8th), before a further small enhancement is possible from the arrival of any fast wind from CH29 either later in the day or during day 2 (9th). This is a small feature, with only a very slight increase visible in MOSWOC Enlil model runs, and was also not present on the previous rotation for persistence to be of use in guidance. Consequently any enhancement to solar winds is very low confidence. Winds will then likely decline further, falling towards background levels by day 4 (11th).

Quiet to Unsettled geomagnetic activity is expected at first, with a chance of rising to Active, and a slight chance of G1/Minor Storms late day 1 and day 2 (8th and 9th) from any fast wind arrival. Easing back to Quiet to Unsettled day 3 and 4, (10th and 11th) with a slight chance of Active.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	**G1 to G2**	No	10	20	1	5
Strong	**G3**	No	1	1	1	1
Severe	**G4**	No	1	1	1	1
Extreme	**G5**	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Nil.

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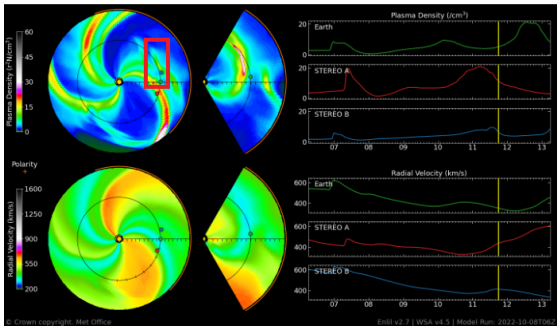
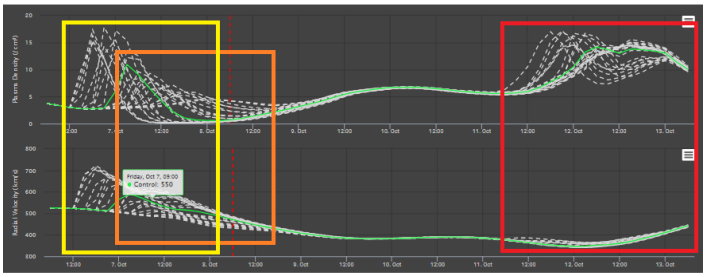
Figure 2: Latest MOSWOC Enlil run and ensemble. Shown boxed are the 03 October CME (yellow); 04 October (orange) and 07 October (red). The deterministic run is essentially a miss for the 07 October NW filament CME, however the situation is marginal, as can be seen from the fuller hits it the ensemble. Even these are relatively minor however, given the four-day-plus transit time.





Radio Blackouts - X-Ray Flares:

Solar Activity has been Moderate, with the recent M1.0 flare observed from AR3116 Eai/Beta in the north centre disc. This is one of seven numbered active regions on the Earth-facing side, lying to the north of the larger, more complex but also more stable AR3112 Fki/Beta-Gamma-Delta. Overall, activity is forecast to persist at Low to Moderate levels, but with a slight chance of isolated X-class flares.

These two regions comprise the majority of the flare risk on the disc. Despite recent splitting into two smaller regions, AR3112 still comprised the main bulk of the sunspot, with at least one, and potentially two, delta spots in what is now its main complex leader region. However this region continues to show a gradual reduction in areal extent, and little sign of significant flaring.

AR3116 remains a relatively simple bipolar region, however the trailer and leader are displaced north-south slightly, giving potential from some shear and induced instability, with further M-flares possible. The other region of note is AR3119, in the northeast, which whilst currently smaller and simpler, has exhibited some slow growth in the last 24 hours. However, significant flares remain unlikely from this spot without further growth. The other regions are all smaller and simpler.

X Ray Flares	**Level**	**Past 24 Hours (Yes/No)**	**Day 1 (00-24 UTC)**	**Day 2 (00-24 UTC)**	**Day 3 (00-24 UTC)**	**Day 4 (00-24 UTC)**
Probability			**(%)**	**(%)**	**(%)**	**(%)**
Active	**R1-R2 M Class**	Yes	40	40	40	40
Very Active	**R3 to R5 X Class**	No	10	10	10	10

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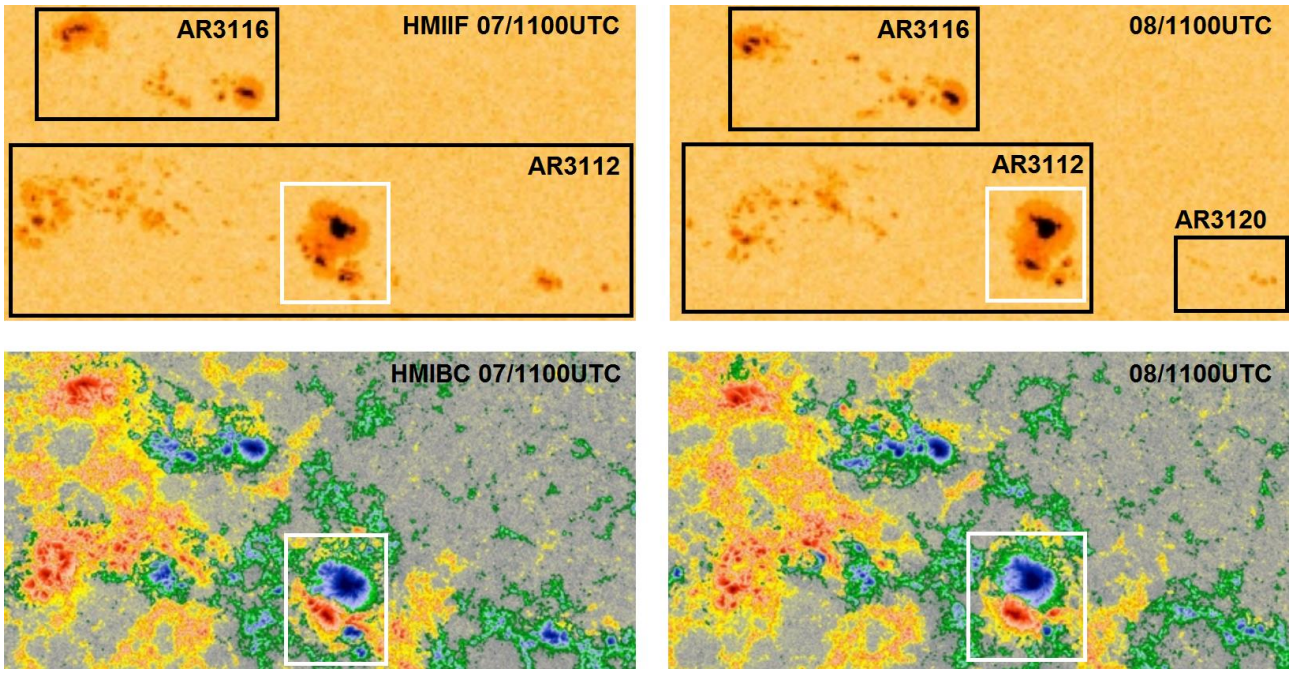
Figure 3: 24-hour changes in the main sunspot groups on the disc. The deltas in the leading portion of AR3112 can be seen to be diverging, lowering the risk of activity although this groups remains large and complex.



Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10MeV) as observed by GOES16 is currently at Background levels.

AR3112 in the centre disc is moving into the western hemisphere. While flare activity from this region has remained relatively subdued, there remains the potential for large M-flares, and a Slight Chance of X-class flares. AR3116 to the north of this region - whilst smaller and much simpler - has recently produced an M1.0 flare and also has the potential for further flares. Combined these two regions give a chance of proton levels increasing with any significant flares that occur, perhaps approaching the S1 level, with a slight chance of exceeding.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	≥ S1	No	10	10	10	10
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

The high energy (greater than 2MeV) electron flux as observed by GOES16 has persisted at Moderate to High levels in the last 24 hours, and little change is anticipated at first. A potential suppression is possible later day 1 and during day 2 from any fast wind arrival of CH29, however

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this is both low confidence, and expected to be relatively weak should it occur. Otherwise, only a gradual decline in peak fluxes is expected, with further periods of High likely each day.

The associated 24-hour electron fluence is forecast to remain Active day 1 (8th) and into day 2 (9th). Confidence then falls due to any suppression of flux that may occur from CH29's fast wind arrival, however Active levels are expected to persist. REFM is currently giving poor guidance after T+24, and should be disregarded beyond this period.

GEO Electron Environment	**Level (cm^{-2} sr^{-1} day^{-1})**	**Past 24 Hours (Yes/No)**	**Day 1 (00-24 UTC)**	**Day 2 (00-24 UTC)**	**Day 3 (00-24 UTC)**	**Day 4 (00-24 UTC)**
Probability (Exceedance)			**(%)**	**(%)**	**(%)**	**(%)**
Active	**≥ 2 MeV ≥ $1x10^{8}$**	Yes	100	70	70	60
Very Active	**≥ 2 MeV ≥ $1x10^{9}$**	No	1	1	1	1

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